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(54) **PLANETARY GEAR SET CENTERING RING**

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(52) **U.S. Cl.** **475/331**; 173/216; 81/57

(58) **Field of Classification Search** 475/298, 475/331, 269; 173/140, 217, 216; 81/57.11, 81/57

See application file for complete search history.

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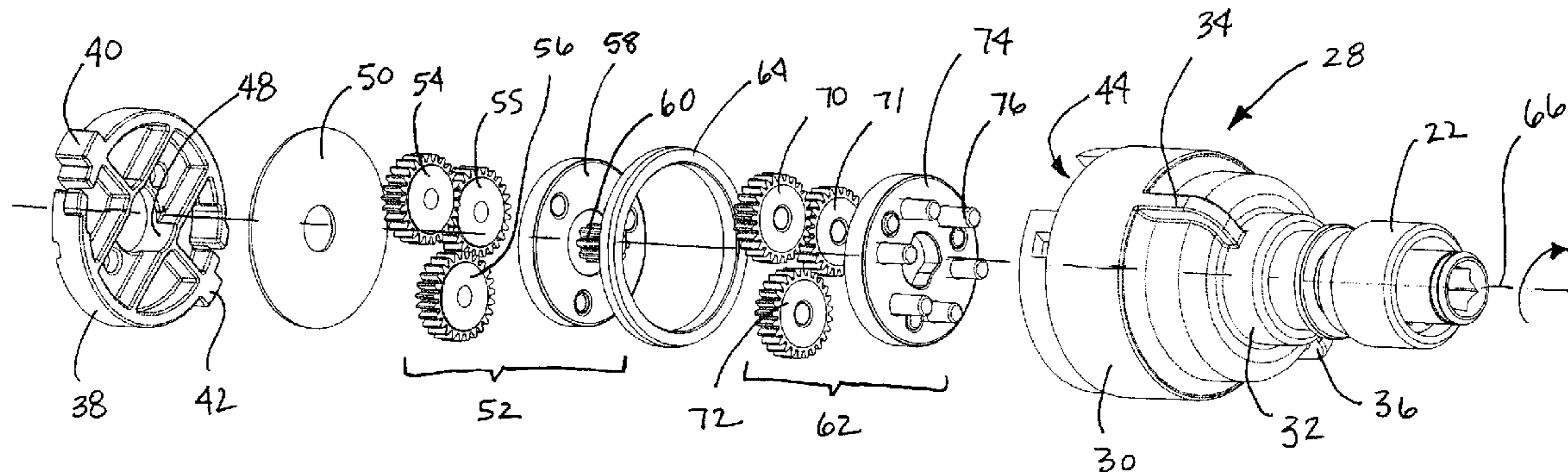
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(57) **ABSTRACT**

A planetary gear set centering ring for use is a planetary gear train. The planetary gear centering ring is adapted to be positioned within a gear train to center a planetary gear carrier and a set of planetary gears within a ring gear of the gear train.

15 Claims, 2 Drawing Sheets



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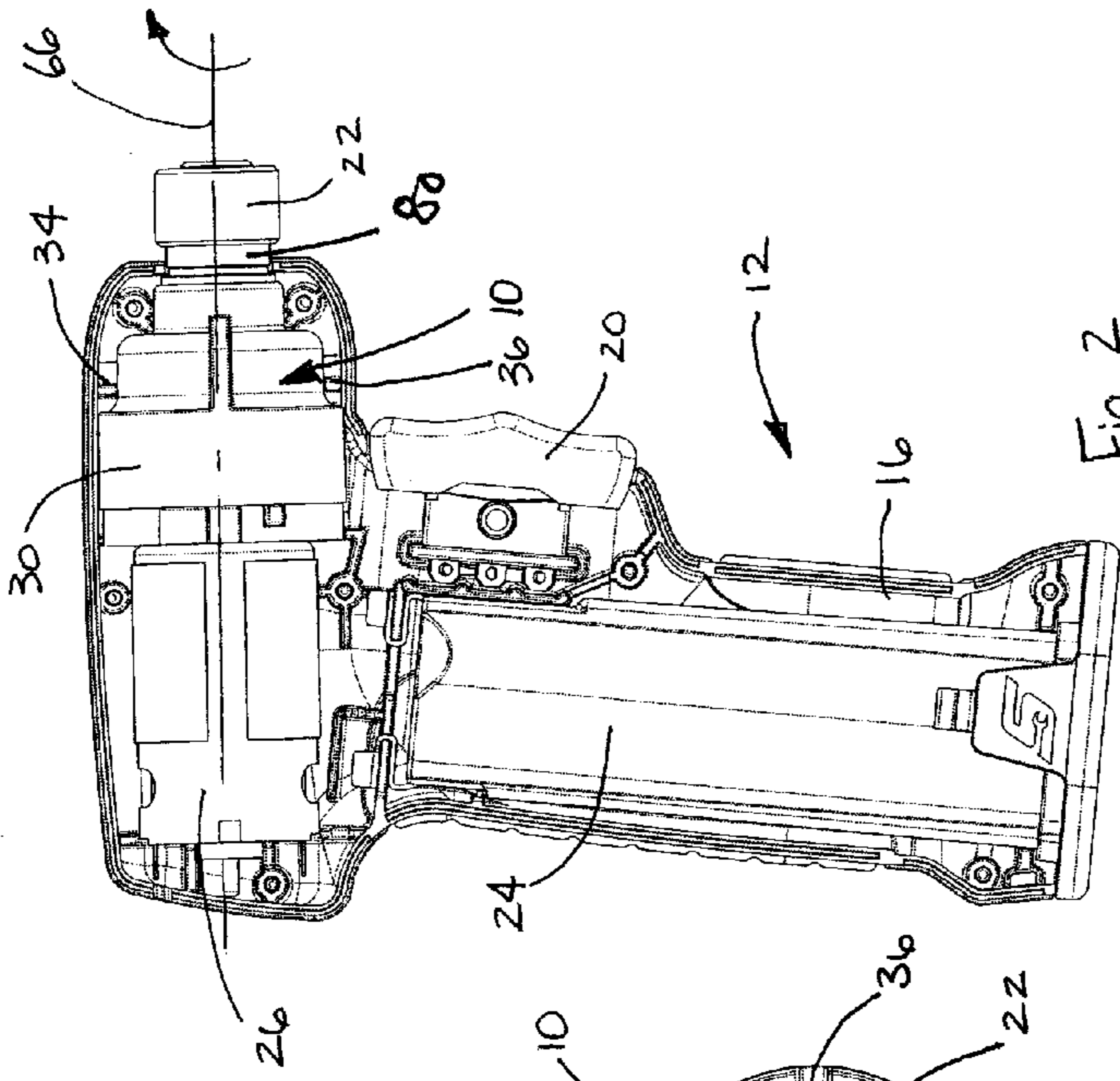


Fig. 2

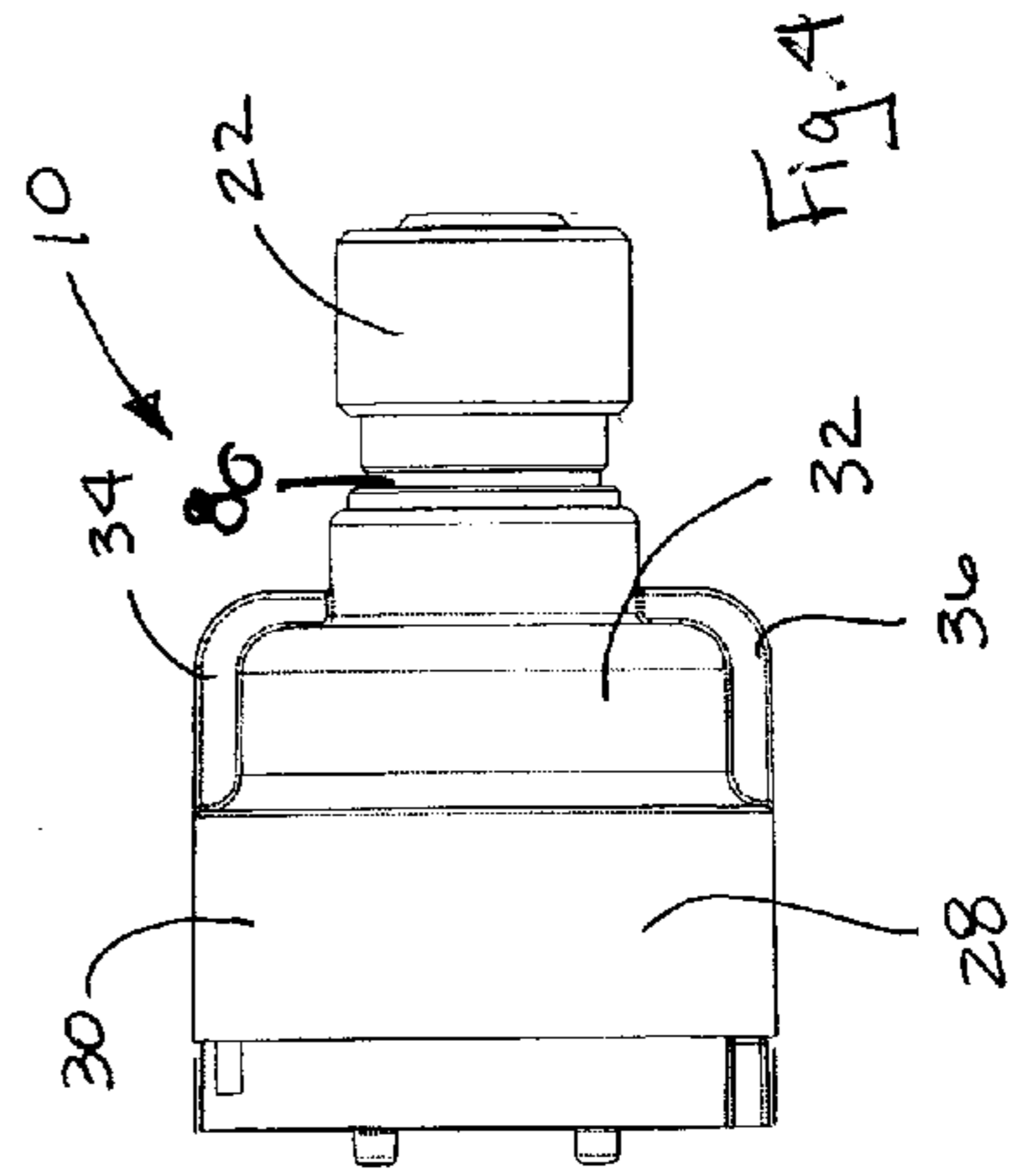


Fig. 4

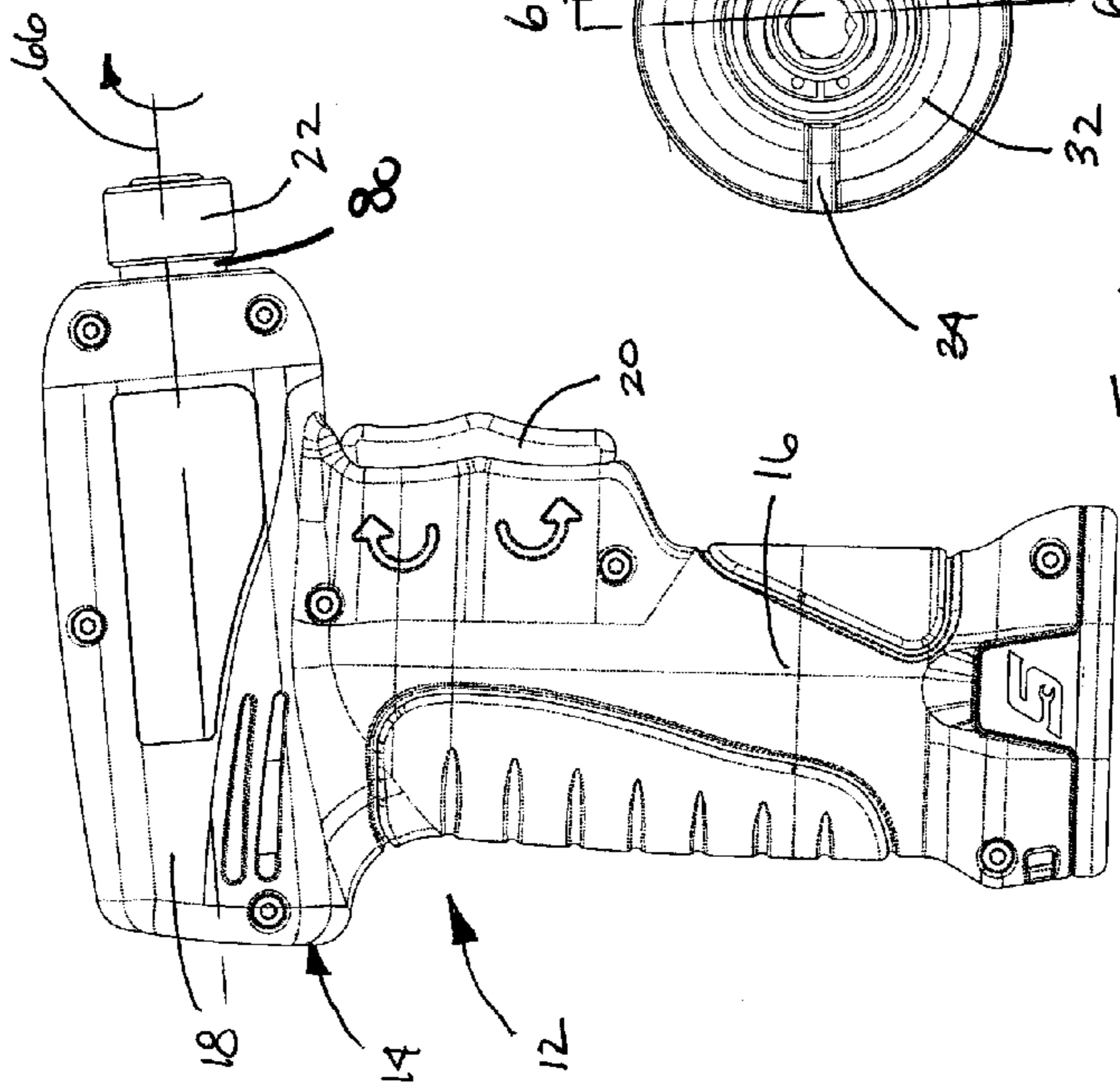


Fig. 1

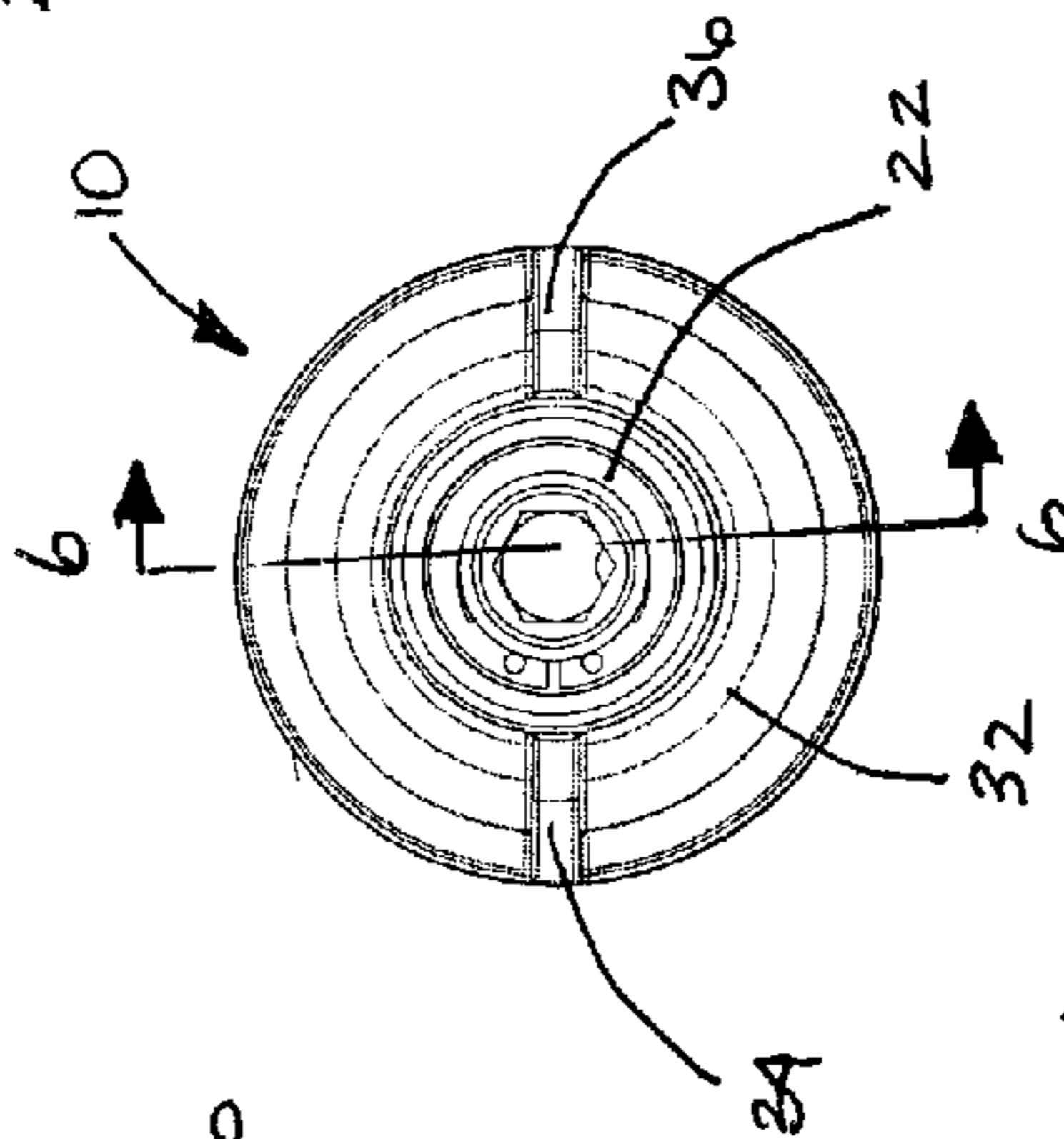


Fig. 5

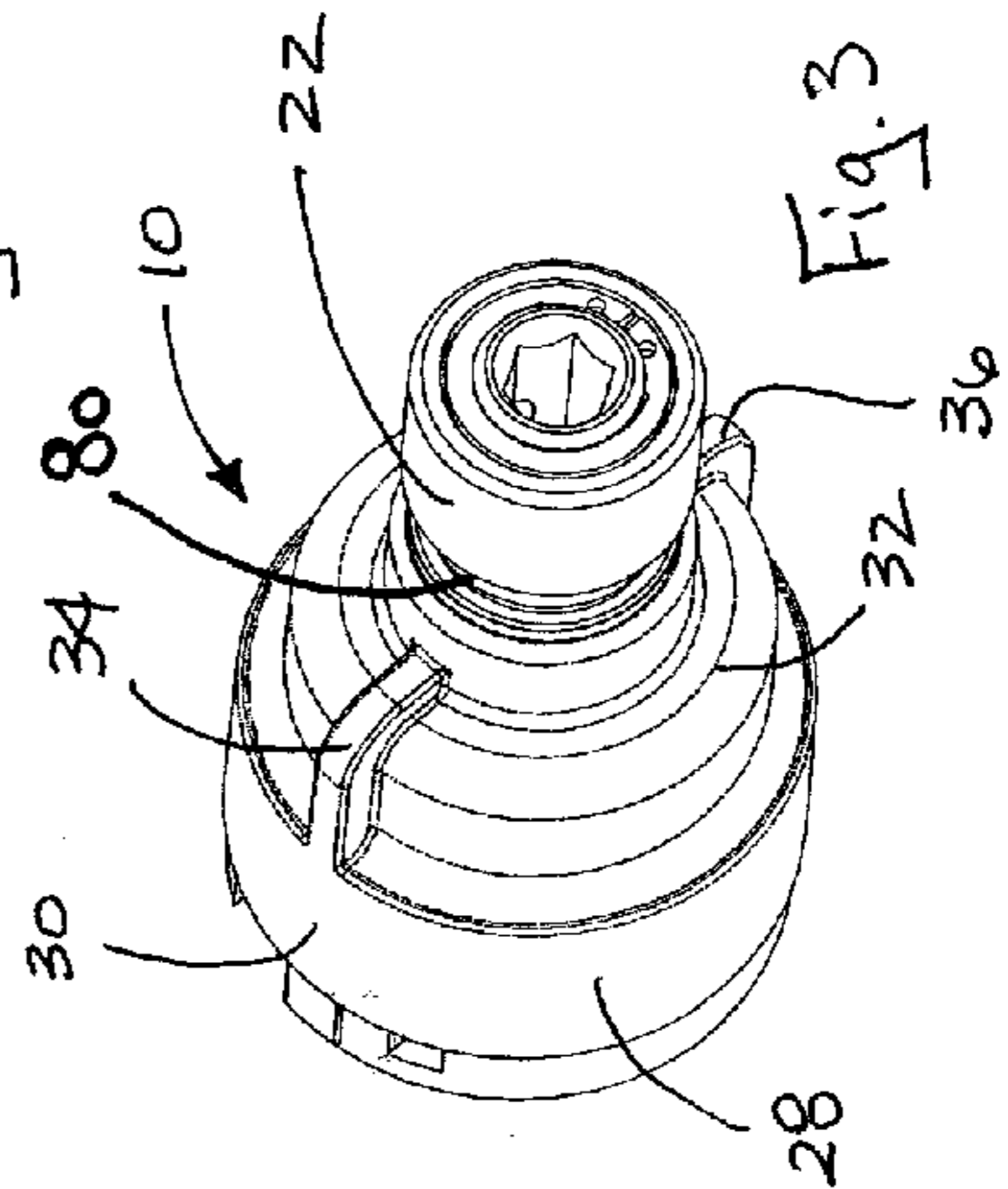
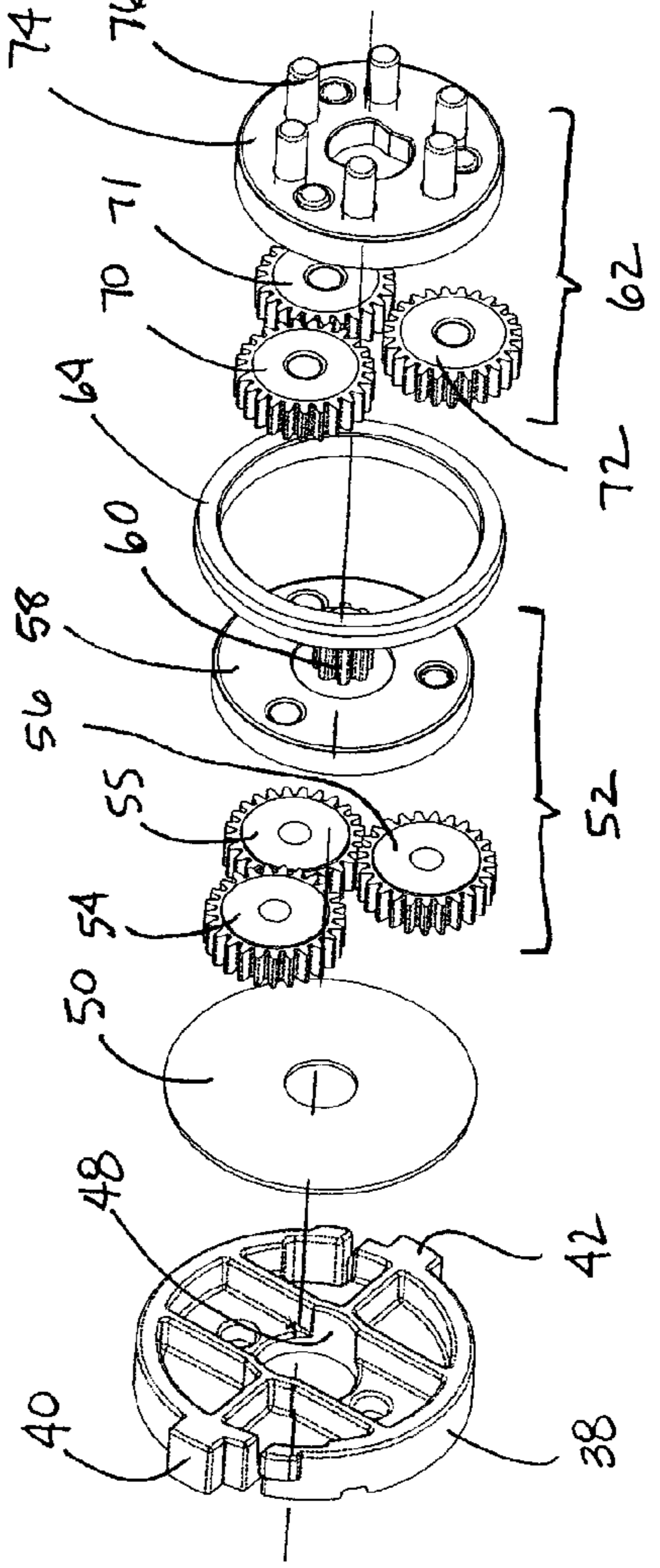
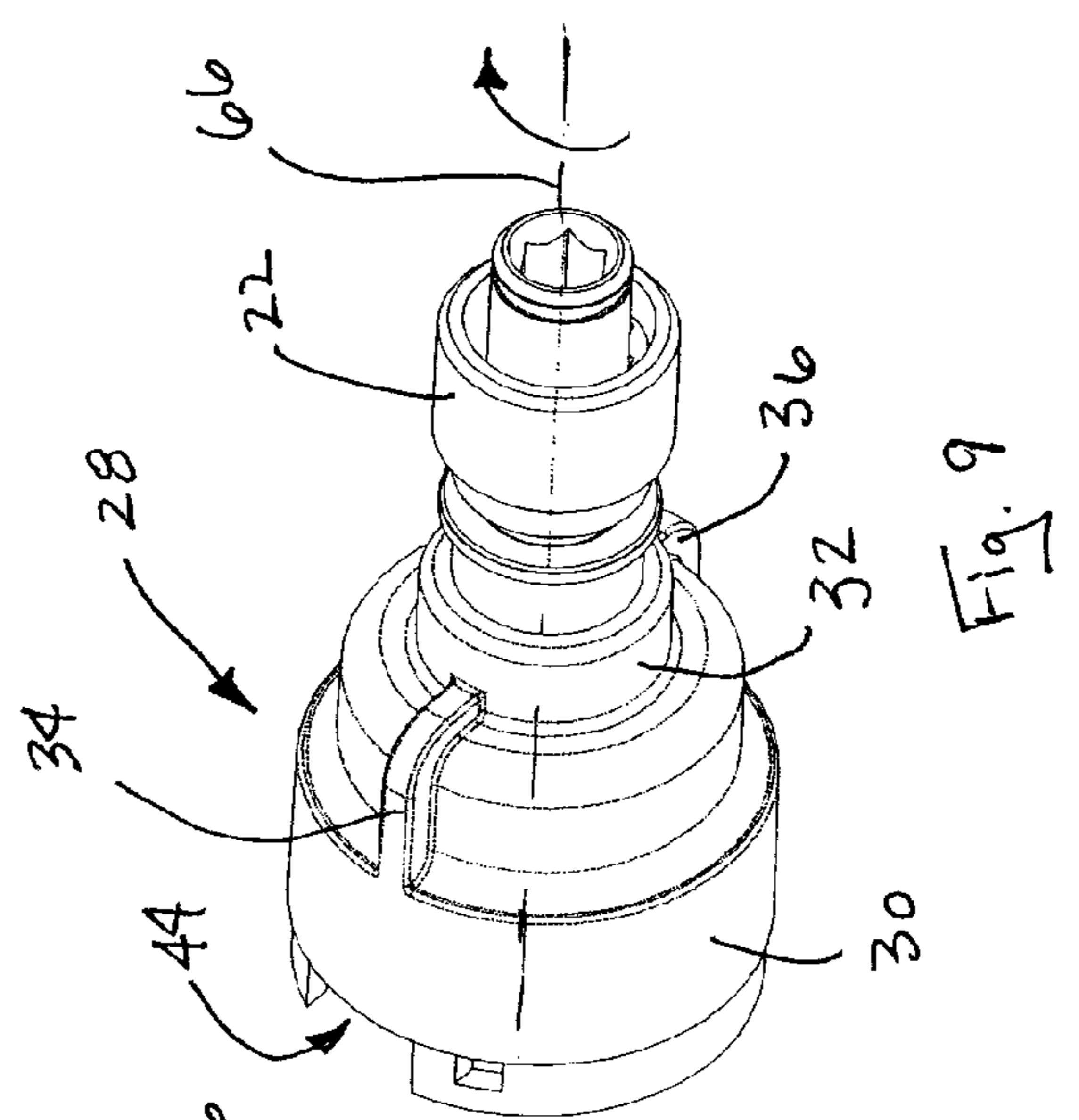
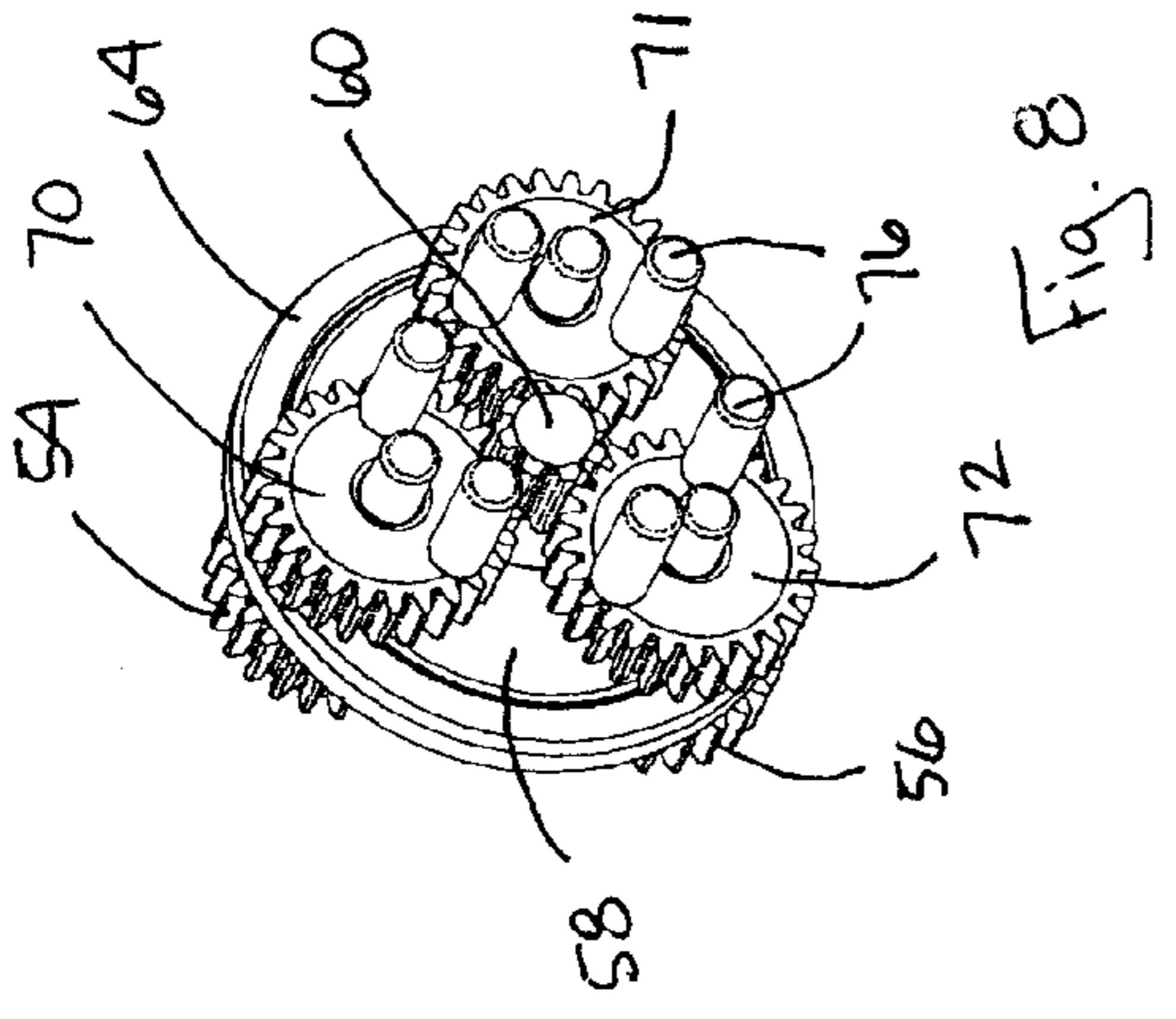
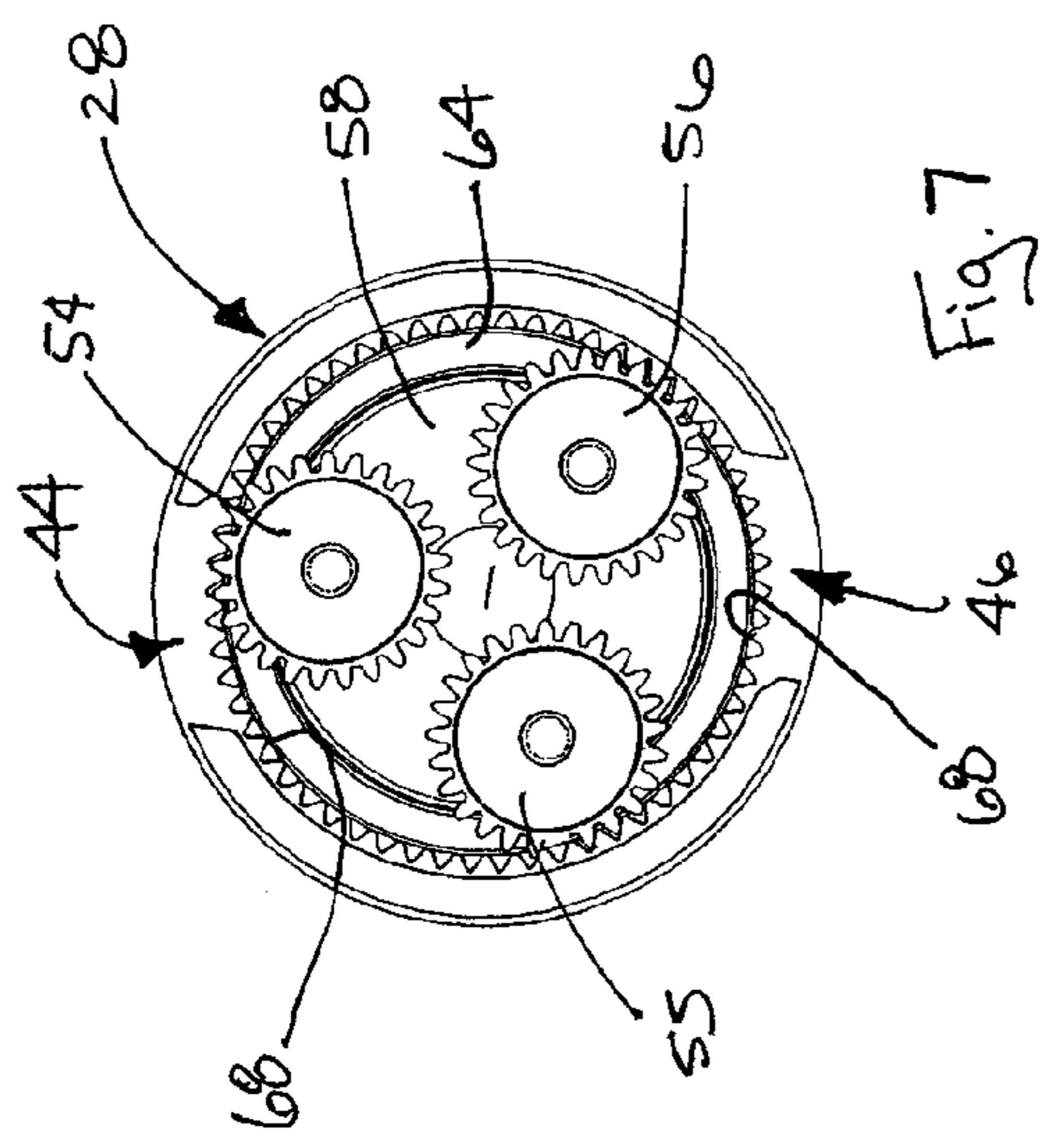
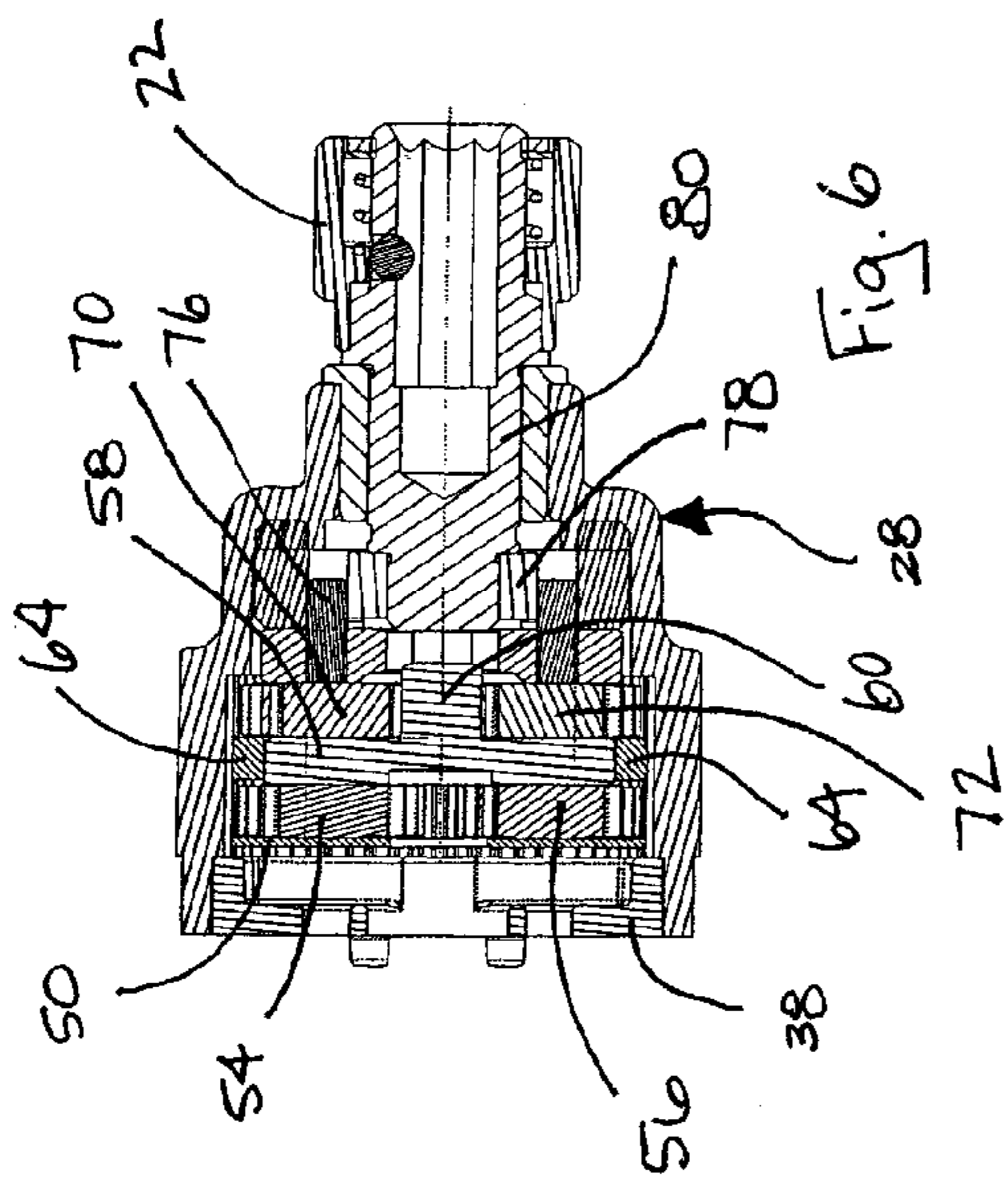


Fig. 3



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PLANETARY GEAR SET CENTERING RING

BACKGROUND

The present disclosure relates to rotary power tools, by way of example and not limitation, to a cordless driver used to install fasteners. More particularly, the present disclosure relates to a planetary gear train for use in power tools.

In accordance with the present disclosure, a planetary gear train is provided for use within a power tool, such as a cordless screwdriver. The planetary gear train comprises a ring gear housing adapted to be coupled to an output shaft designed to accept driver bits. The planetary gear train also includes a series of planetary gears pivotally coupled to a planetary gear carrier that is positioned within the ring gear housing. Rotation of a sun gear coupled to an electric motor rotates the planetary gears, which, in turn, rotates a first gear carrier.

In illustrative embodiments, the planetary gear train includes a centering ring positioned within the ring gear housing. The planetary gear carrier is adapted to be positioned within the centering ring. The centering ring is adapted to prevent the planetary gear carrier from shifting in a direction that is perpendicular to the axis of rotation of the gear train when an excessive amount of torque is applied to the output shaft of the power tool. During normal usage, the centering ring is designed to move freely or float within the ring gear to reduce driveline friction. In portable power tools where gear trains might be made from plastics material, the centering ring prevents distortion of the ring gear and the planetary gear carrier to minimize the amount of torque applied to individual gear teeth caused by gear train offset.

Additional features of the disclosure will become apparent to those skilled in the art upon consideration of the following detailed description of illustrative embodiments exemplifying the best mode of carrying out the disclosure as presently perceived.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention and the advantages thereof will become more apparent upon consideration of the following detailed description when taken in conjunction with the accompanying drawings of which:

FIG. 1 is a side elevational view of a cordless power tool showing a generally vertical handle having an actuation trigger and a generally horizontally disposed power head coupled to the handle and having an output shaft extending from one end of the power head;

FIG. 2 is a side elevational view of the power tool with a cover removed to show a generally vertically extending battery positioned within the handle and an electric motor coupled to a planetary gear train, which, in turn, is coupled to an output chuck;

FIG. 3 is a perspective view of the planetary gear train coupled to the output chuck of the power tool removed from the power tool;

FIG. 4 is a side elevational view of the planetary gear train and output chuck of the power tool, as shown in FIG. 3;

FIG. 5 is a front view of the planetary gear train and output chuck of the power tool, as shown in FIGS. 3 and 4;

FIG. 6 is a cross sectional view taken along line 6-6 of the FIG. 5 showing first and secondary planetary gear sets positioned within the ring gear housing and coupled to the output shaft and output chuck of the power tool;

FIG. 7 is a rear view of the planetary gear train showing three planetary gears positioned within the ring gear housing and coupled to a first planetary gear carrier, the first planetary

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carrier positioned to lie near the centering ring that is positioned between the first planetary gear carrier and the ring gear housing;

FIG. 8 is a perspective view of a set of planetary gears coupled to the first planetary gear carrier wherein the centering ring is positioned around the perimeter of the planetary gear carrier; and

FIG. 9 is an exploded view of the planetary gear set showing a motor adaptor at the left followed by a spacer plate, three planetary gears and also showing a first planetary gear carrier, a centering ring, and a second set of planetary gears that are coupled to a secondary planetary gear carrier and further showing the ring gear housing coupled to the output chuck of the power tool.

DETAILED DESCRIPTION

While the present disclosure may be susceptible to embodiments in different forms, they are shown on the drawings, and herein will be described in detail, embodiments with the understanding that the present description is to be considered an exemplification of the principles of the disclosure and is not intended to limit the disclosure to the details of construction and the arrangements of components set forth in the following description or illustrated in the drawings.

A planetary gear train 10 is adapted for use in a cordless power tool 12, as shown, for example, in FIGS. 1 and 2 by way of example and not limitation. While a cordless power tool is shown, it is contemplated that planetary gear train 10 can be used in other rotary tools. Cordless power tool 12 includes a housing 14 having a vertically oriented handle 16 and a horizontally oriented power head 18. Handle 16 includes a trigger 20 that is used to operate the power tool 12. Power tool 12 also includes an output chuck 22 coupled to power head 18.

Power tool 12 includes a battery 24 positioned within handle 16 and an electric motor 26, as shown, for example, in FIGS. 1 and 2. Electric motor 26 is one means for driving the power tool and other means could also be used including pneumatic. Electric motor 26 is positioned within power head 18 and is electrically connected to trigger switch 22 and battery 24. Electric motor 26 is coupled to planetary gear train 10 that is used to drive output chuck 22. Planetary gear train 10 includes a ring gear housing 28, as shown, for example, in FIG. 3.

Ring gear housing 28 includes a cylindrical portion 30 and a tapered region 32 extending from cylindrical portion 30, as shown, for example, in FIGS. 3 and 4. Tapered region includes first and second flanges 34, 36 that are adapted to engage housing 14 of power tool 12 to prevent rotation of ring gear housing 28 within housing 14 of power tool 12. Tapered region 32 is positioned to lie near output chuck 22 of power tool 12. Positioned on the inside of ring gear housing 28 are gear teeth 68, as shown, for example, in FIG. 7. The tips of gear teeth 68 form the inner diameter of ring gear housing 28.

Planetary gear train 10 includes a mounting plate 38 that forms the rear portion of ring gear housing 28, as shown, for example, in FIGS. 6 and 9. Mounting plate 38 is adapted to be mounted to electric motor 26. Mounting plate 38 includes a pair of flanges 40, 42 that are adapted to be positioned within first and second recesses 44, 46 of ring gear housing 28. Mounting plate 38 also includes a central aperture 48 that is adapted to permit the passage of a pinion gear from electric motor 26. Positioned in front of mounting plate 38 is spacer 50.

In front of spacer 50 is a first planetary gear set 52, as shown, for example, in FIG. 9. First planetary gear set 52 includes planetary gears 54-56 that are adapted to be coupled

to a first planetary gear carrier **58**. Planetary gears **54-56** can be made from nylon or other plastics materials, composites or alloys. First planetary gear carrier **58** is adapted to be coupled to planetary gears **54-56**.

First planetary gear carrier **58** also includes pinion gear **60** that is adapted to drive secondary planetary gear set **62**, as shown, for example, in FIGS. **6** and **9**. Planetary gear train **10** also includes a centering ring **64** positioned within ring gear housing **28**. Centering ring **64** includes an external diameter that is less than the internal diameter of ring gear housing **28** to allow centering ring **64** to rotate freely within the ring gear housing **28** during use of power tool **12**. First planetary gear carrier **58** is adapted to be positioned within centering ring **64** and includes an outer diameter that is less than the inner diameter of centering ring **64**.

Centering ring **64** is a ring that is adapted to be positioned between ring gear housing **28** and first planetary gear carrier **58**. Centering ring **64** can be made from steel, aluminum, or other metals that are rigid, which could also include non-metal materials, such as carbon fiber and ceramics. The purpose of centering ring **64** is to keep first planetary gear carrier **58** centered within ring gear housing **28** even if a large torque load is applied to first planetary gear carrier **58**. By way of example but not limitation, large torque loads may be applied to the first planetary gear carrier **58** for example if a user of power tool **12** manually twists handle **16** about the axis of rotation **66** of gear train **10** to tighten a fastener.

Without centering ring **64**, excessive torque loads applied to gear train **10** would cause first planetary gear carrier **58** and planetary gears **54-56** to shift perpendicular to the axis of rotation **66** of gear train **10**. Movement of planetary gear carrier **58** and planetary gears **54-56** in a perpendicular direction causes additional force to be applied to certain teeth of planetary gears **54-56**, which can cause breakage of teeth from planetary gears **54-56**. Under normal power tool usage, centering ring **64** is adapted to move freely or float between ring gear housing **28** and first planetary gear carrier **58**. Allowing centering ring **64** to float between ring gear housing **28** and first planetary gear carrier **58** reduces driveline friction during operation of power tool **12**.

Centering ring **64** can also be used to correct a ring gear housing **28** that is molded out-of-round. Positioning a round metal centering ring **64** within an out-of-round ring gear housing **28** forces ring gear housing **28** into the desired round shape. Under these conditions, centering ring **64** engages the inner diameter of ring gear housing **28** and does not move freely. First planetary gear carrier **58** would still be positioned within centering ring **64** and rotates within inner diameter of centering ring **64**.

Pinion gear **60** of first planetary gear carrier **58** is adapted to engage second planetary gears **70-72** of second planetary gear set **62**, as shown, for example, in FIGS. **6** and **9**. Second planetary gears **70-72** engage gear teeth **68** of ring gear housing **28** and are coupled to second planetary gear carrier **74**. Pinion gear **60** of first planetary gear carrier **58** drives planetary gears **70-72**, which, in turn, drive second planetary gear carrier **74**.

Secondary gear carrier **58** of secondary planetary gear set **62** includes a series of outwardly extending posts **76** that are adapted to engage and drive collar **78**, as shown, for example, in FIG. **6**. Collar **78** is coupled to output shaft **80**. Output shaft **80** extends from ring gear housing **28** and is formed to include output chuck **22**. Output chuck **22** is adapted to accept a screwdriver bit or socket to install a fastener.

The present arrangement is a double gear reduction type because planetary gear train **10** includes first and second planetary gear sets **58**, **62**. Double reduction gear sets effec-

tively multiply the torque output created by electric motor **26** to provide for a greater amount of torque at output shaft **80** and output chuck **22**. It is contemplated that a second centering ring can be used to maintain the position of second planetary gear carrier **74** within ring gear housing **28** to prevent damage to the teeth of planetary gears **70-72**. It is also contemplated that a single planetary gear set and centering ring can be used in situations where the torque multiplication of a second planetary gear set is not required.

In use, the operator of power tool **12** pulls trigger **20** to allow electricity stored in battery **24** to energize electric motor **26**. Energizing electric motor **26** causes a pinion gear mounted on the output shaft of motor **26** to rotate planetary gears **54-56** about gear teeth **68** of ring gear housing **28**. Rotation of planetary gears **54-56** cause rotation of first planetary gear carrier **58** within centering ring **64**. Rotation of first planetary gear carrier **58** causes rotation of pinion gear **60**. Rotation of pinion gear **60** causes rotation of planetary gears **70-72** about gear teeth **68** of ring gear housing **28**.

Rotation of planetary gears **70-72** causes rotation of secondary planetary gear carrier **74**. Rotation of secondary planetary gear carrier **74** causes rotation of collar **78** and output shaft **80** and output chuck **22**. If the maximum torque of output shaft **22** is exceeded when installing a fastener, the user may grab and forcibly rotate handle **16** about the axis of rotation **66** of power head **18** to completely install the fastener. Such a situation maybe more likely to arise when battery **24** is low on power.

The excessive amount of torque applied to output shaft **80** by forcibly rotating handle **16** about the axis of rotation **66** causes a reverse torque load to be transmitted backward through second and first planetary gear sets **62**, **58**, causing first planetary gear carrier **58** to be forced in a direction that is perpendicular to the axis of rotation **66** of gear train **10**. When a reverse torque load occurs, centering ring **64** engages the inner diameter of ring gear housing **28** and outer diameter of first planetary gear carrier **58** to prevent or minimize perpendicular movement of first planetary gear carrier **58** and planetary gears **54-56**. By maintaining the orientation of first planetary gear carrier **58** within ring gear housing **28** stress loads applied to individual gear teeth of planetary gears **54-56** is minimized.

While embodiments have been illustrated and described in the drawings and foregoing description, such illustrations and descriptions are considered to be exemplary and not restrictive in character, it being understood that only illustrative embodiments have been shown and described and that all changes and modifications that come within the spirit of the invention are desired to be protected. The applicants have provided description and figures which are intended as illustrations of embodiments of the disclosure, and are not intended to be construed as containing or implying limitation of the disclosure to those embodiments. There are a plurality of advantages of the present disclosure arising from various features set forth in the description. It will be noted that alternative embodiments of the disclosure may not include all of the features described yet still benefit from at least some of the advantages of such features. Those of ordinary skill in the art may readily devise their own implementations of the disclosure and associated methods, without undue experimentation, that incorporate one or more of the features of the disclosure and fall within the spirit and scope of the present disclosure and the appended claims.

What is claimed is:

1. A planetary gear train for a power tool having an output shaft, the planetary gear train comprising:

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a ring gear having an inner diameter and gear teeth disposed on an inside surface of the ring gear;
 a planetary centering ring positioned within the ring gear, the planetary centering ring having an inner diameter and an outer diameter that is less than the inner diameter of the ring gear;
 a set of planetary gears positioned within the ring gear, the planetary gears engage the gear teeth of the ring gear;
 a planetary gear carrier is positioned within the planetary centering ring and coupled to the planetary gears, the planetary gear carrier having an outer diameter that is less than the inner diameter of the planetary centering ring; and
 the planetary gear carrier moves within the centering ring when the planetary gears are driven to rotate the planetary gear carrier and is limited from shifting perpendicularly to the axis of rotation when a reverse torque load is applied to the output shaft of the power tool.

2. The planetary gear train of claim 1, wherein the planetary centering ring is generally rigid and the ring gear is made from a plastics material.

3. The planetary gear train of claim 2, wherein the planetary centering ring moves freely between the inner diameter of the ring gear and the outer diameter of the planetary gear carrier.

4. The planetary gear train of claim 3, wherein the gear train includes a second set of planetary gears driven by the planetary gear carrier.

5. The planetary gear train of claim 4, further including a second planetary gear carrier that is coupled to the second set of planetary gears.

6. A rotary power tool comprising:
 a housing;
 an output shaft extending from the housing;
 a battery positioned within the housing;
 an electric motor positioned within the housing and electrically coupled to the battery;
 a ring gear having an inner diameter and gear teeth disposed on an inside surface;
 a centering ring positioned within the ring gear, the centering ring having an inner diameter and an outer diameter that is less than the inner diameter of the ring gear;
 a set of planetary gears positioned within the ring gear and driven by the electric motor, the planetary gears engage the gear teeth of the ring gear;
 a planetary gear carrier positioned within the centering ring and coupled to the planetary gears, the planetary gear carrier having an outer diameter that is less than the inner diameter of the planetary centering ring; and

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the planetary gear carrier moves within the centering ring when the planetary gears are driven by the electric motor, the centering ring limits the planetary gear carrier from shifting perpendicularly to the axis of rotation when a reverse torque load is applied to the output shaft of the power tool.

7. The rotary power tool of claim 6, wherein the centering ring is generally rigid and the ring gear is made from a plastics material.

8. The rotary power tool of claim 7, wherein the centering ring is positioned between the inner diameter of the ring gear and the outer diameter of the planetary gear carrier.

9. The rotary power tool of claim 8, wherein the gear train includes a second set of planetary gears driven by the planetary gear carrier.

10. The rotary planetary gear train of claim 9, further including a second planetary gear carrier that is coupled to the second set of planetary gears.

11. A cordless driver gear train comprising:
 a housing having an inner diameter, the housing including a plurality of gear teeth formed on the inside of the housing;
 a metallic centering ring positioned within the housing;
 a planetary gear carrier positioned within the centering ring, the planetary gear carrier rotatable within the centering ring;
 a set of planetary gears coupled to the planetary gear carrier, the planetary gears engage the gear teeth of the housing and are positioned to lie near the centering ring; and
 the centering ring limits the planetary gear carrier from shifting perpendicularly to the axis of rotation of the gear train when torque is applied to the planetary gear carrier by a reverse torque load applied to the cordless driver.

12. The cordless driver gear train of claim 11, wherein the centering ring moves freely between the inner diameter of the housing and the outer diameter of the planetary gear carrier.

13. The cordless driver gear train of claim 12, further including a second set of planetary gears positioned with the housing and driven by the planetary gear carrier.

14. The cordless driver gear train of claim 13, further including a second planetary gear carrier that is coupled to the second set of planetary gears.

15. The cordless driver gear train of claim 14, further including an output shaft driven by the second planetary gear carrier.

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